STUDIES IN PHARAOH'S ANT, *MONOMORIUM PHARAONIS* (L.)
(6) EXTERNAL CHARACTERS, SIZE VARIATION AND CEPHALIC RATIOS

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INTRODUCTION

During large-scale breeding experiments with *Monomorium pharaonis* (L.) (Peacock, A. D. and Baxter, A. T., 1949, *Ent. mon. Mag.*, **85**: 256-60) we have obtained abnormal individuals which deserve consideration. Such individuals, however, cannot be described and their significance discussed without first detailing the characters of the normal insects, the more so as descriptions by earlier workers (Stitz, H., 1914, *Die Ameisen*, Stuttgart; Donisthorpe, H., 1927, *British ants*, London) are incomplete. This paper then aims to complete the study of the external characters of normal individuals, but leaves the consideration of the abnormal specimens (and, for special reasons, the normal thorax) until a later publication. We are indebted to Prof. A. D. Peacock for much helpful criticism.

EXTERNAL CHARACTERS OF WORKER, FEMALE AND MALE

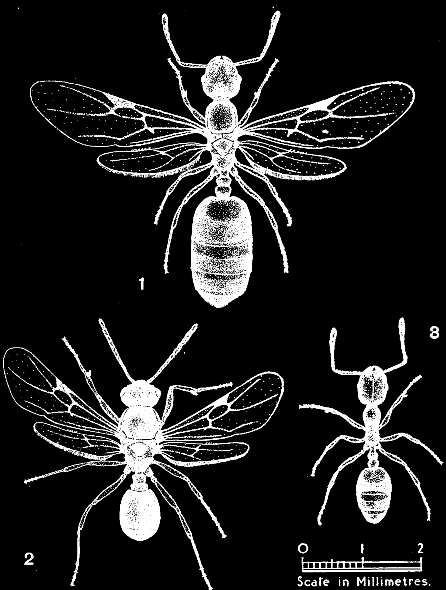
There are three types of individuals of *M. pharaonis*, the fertile male, and two castes comprising the large and fertile female (the so-called 'queen') and the small, sterile worker whose organisation is female (figs. 1-3).

WORKER (fig. 3).—Length 2.0-3.4 mm. Uniformly yellowish brown. Sparsely hirsute. *Head* (fig. 6): yellow-brown; rectangular, longer than broad; occipital border very slightly concave. Eye: small, black, oval, with about 25 ommatidia; no ocelli. Mandible: stoutly built, with 4 or 5 teeth (terminal tooth long and curved) and characteristic chaetotaxy (fig. 9). Clypeus: concave, interior border with 4 distinct protuberances, sides very feebly concave. Antennae: geniculate, with long fully clubbed scape; flagellum eleven-segmented with a 3-segmented club; pedicel distinctly longer than following seven uniform segments. *Thorax*: Uniformly yellow-brown; unsutured but grooved. Legs: uniformly yellowish, hirsute; tibiae have bristles; strigil on front tibia. *Abdomen*: Consists of epinotum, petiole, post-petiole, and gaster; epinotum forms part of thorax; petiole and post-petiole form slender flexible link between thorax and gaster. Gaster: oval, 4-segmented, banded brown on yellowish background; first segment lateral edges have band continued forward producing an oval yellow patch (fig. 3); two large antero-dorsal air sacs, visible in the living insect, show through this patch and meet at a point posterior to post-petiole, and give rise to a pattern resembling W.

FEMALE (fig. 1).—Length 4.3 mm. Brown in colour. *Head* (fig. 4): blackish-brown; quadrate. Eye: black, fairly large, round-oval, with about 200 ommatidia; 3 ocelli; median ocellus lying fairly flat, lateral members of dorsal ocelli raised and directed backwards at 30° to head surface; base of each ocellus has a crescentic area of blackish chitin; head carried almost horizontally, thus ocelli lie fairly flat. Mandible: stoutly built like worker's but with different chaetotaxy (fig. 7). Clypeus: rather flat, anterior border transverse with 4 very slight protuberances, sides very feebly sinuate; chaetotaxy different from worker's (cf. figs. 7 & 9). Antennae: similar to worker in size and composition. *Thorax*: Brown, with patches of blackish chitin on the following plates — pronotum, scutum of mesonotum, scutellum, sternite of mesothorax, and epinotum. *Abdomen*: As worker in most respects. Gaster: much bigger; markings similar to worker, but air sacs less prominent due to darker colour of chitin.

The females are winged on emergence, but after a few days become deälated, a process carried out mainly by the workers though the females have been observed trying to sever their own wings.

MALE (fig. 2).—Length 3.1 mm. Mainly black with no suggestion of brown characteristic of other two castes. *Head* (fig. 5): black; very round. Eye: very large, with about 450 ommatidia which have a basic purple pigment; 3 ocelli; raised well above general level of head, lateral members of dorsal ocelli directed backwards at 45°; shallow groove runs forward from median ocellus; head depressed at 60° to line of body, thus ocelli raised considerably to be directed horizontally. Mandible: slender and weak; 3 teeth (terminal tooth long and curved, third from apex small). Clypeus: virtually straight and characteristic chaetotaxy (fig. 8). Antennae: filiform; short black scape; flagellum 12-segmented, straw-coloured; all joints except last subequal, twice as long as broad; last joint pointed, as long as the two penultimate joints together. *Thorax*: Black. Legs: straw-coloured; first coxa and femur as well as second and third coxae blackish. *Abdomen*: Black. Pedicel: lighter in colour than thorax. Gaster: uniform polished black; 4-segmented.



FIGS. 1-3.—Adults of *Monomorium pharaonis* (L.); 1, female; 2, male; 3, worker.

The male is winged and never becomes deälated.

The diagnostic characters of the three types of individuals are summarised in Table 1.

TABLE 1. Summary of the diagnostic characters of the worker, female and male of *Monomorium pharaonis* (L.)

Characters	☿	♀	♂
Length	2.2—2.6 mm.	4.3 mm.	3.1 mm.
General colour	Yellowish-brown	Brown	Black
Head	Rectangular Yellow-brown	Quadrate Black-brown	Rounded Purple-black
Mandibles	Large and stout 4-5 teeth	Large and stout 4 teeth	Slender 3 teeth
Clypeus	Anterior border concave and 4-notched	Anterior border flat with 4 feeble notches	Anterior border feebly sinuate — almost linear
Eye	Small black ommatidia — 25	Large black ommatidia — about 200	Larger, purplish ommatidia — about 450
Ocelli	None	1 large round central 2 smaller round lateral members	1 large elevated central 2 oval elevated lateral members
Antennae	Long scape (clubbed) Flagellum — 11-segmented — 3 distal segments elongate forming club Pedicel distinct in shape	Long scape (clubbed) Flagellum — 11-segmented — 3 distal segments elongate forming club Pedicel distinct in shape	Short scape (not clubbed) Flagellum — 12-segmented — last segment elongate Pedicel not distinct in shape
Gaster	4-segmented Uniformly yellow-brown 1st segment has central yellowish patches	4-segmented Dark brown, with light bands when extended 1st segment has central light patches similar to ☿	4-segmented Uniformly black

SIZE VARIATION

The degrees of size variation observed merit further attention.

Female: According to Donisthorpe (1927, *British Ants*, London) the female is 4-4.8 mm. long. Our observations on at least 40 specimens, show however, that this range is too wide, that of 4.2-4.6 mm. being much more typical. The variation is largely due to whether the female is newly emerged, when there is very little distension of the gastral segments, or at the height of laying, when these segments are considerably distended. Generally speaking, variation in female size is extremely small, especially when comparison is made with the condition existing in the worker caste.

Male: Very little variation in size occurs in the males; in at least 20 specimens the large majority measured 3.2-3.3 mm., with a range of 3.1-3.4 mm.

Worker: At first sight one gets the impression that there are two categories of workers, large (3.4 mm.) and small (2 mm.), which raises the possibility of specialisation. Long and careful study, however, shows this impression to be erroneous. In the nest cell of our artificial colonies both large and small individuals perform the same nursery duties to both eggs and larvae, while large and small workers occur with equal frequency on trail. The fact that the worker caste is monomorphic has been proved by measurements of about 500 workers from a colony of about 900, giving a histogram (length/ numbers) of the type shown in Fig. 10. Here, by 'length' is meant the distance from the anterior border of the clypeus to the posterior border of the pedicel, the gaster being omitted, as its size is variable according to the degree of telescoping of the segments. The histogram was compiled from information of the kind given in Table 2, which shows the type of measurements made on all the workers. The measurements (arbitrary units) were obtained by mounting the ants on slides and magnifying them about 44 times by means of a lantern projector. The histogram shows the 'norm' of size to be of the order 2.7 mm. (assuming mean gaster measurement to be 0.9 mm.) and the deviation in size on either side of this is 0.7 mm., a value not beyond that expected from chance deviation, the graph obtained being a normal distribution curve. Wheeler (1923, *Social life among the insects*, New York) has suggested that the term 'desmergate' might be employed to designate the intermediate forms between the small and large workers in such genera as *Monomorium, Formica,* etc. Thus it might be argued that the individuals at the extreme ends of the histogram, *i.e.* of size 2.0 mm. and 3.4 mm., are micrergates and macrergates respectively and the intermediates are desmergates. This we feel is untenable in the case of *M. pharaonis* since (*a*) the forms intermediate in size are in the vast majority and hence do not constitute an atypical phase, and (*b*) the smaller and larger individuals are present in all new broods and therefore are not produced under particular circumstances such as when females are producing their first broods or when colonies are older and well-established. Variation in size of workers is probably due to collective and competitive feeding during the association of individuals of different instars. All larvae, at least up to the half-grown larval stage, tend to be massed together so that the larvae in the centre will often fail to obtain sufficient food and so sometimes give rise to midget workers. Conversely, large workers might be produced from the larvae lying on the periphery of the mass.

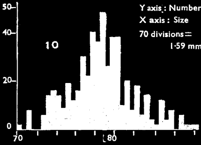


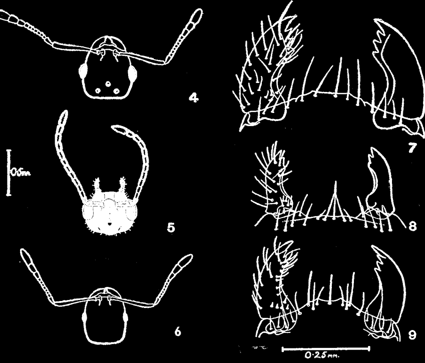
Fig. 10.—Histogram of size variation of workers in *Monomorium pharaonis* (L.) showing a normal distribution.

TABLE 2.—Samples of measurements of workers of *M. pharaonis* from which histogram (size/number — fig. 10) was drawn. Magnification about 44.

Specimen	Length of head	Length of thorax	Length of pedicel	Total length
1	27.0	29.5	17.0	73.5
2	28.5	31.5	18.0	78.0
3	29.0	32.5	18.5	80.0
4	29.0	31.0	18.0	78.0
5	29.0	29.5	16.5	75.0
6	28.0	29.0	16.0	73.0
7	31.0	35.0	20.5	86.5
8	31.0	36.0	20.5	87.5
9	27.5	29.0	16.0	72.5
10	23.5	29.5	17.0	70.0

CEPHALIC RATIO

The shapes of the heads in male, female and worker are completely different (compare figs. 4, 5 and 6). We have tried to illustrate this mathematically by dividing the greatest head width by greatest head length and using the term 'Cephalic Ratio' (CR) for the result. The measurements were made by lantern projection of the specimens — magnification about 70 times — and the units used were purely arbitrary. The CR of females, males and workers are distinctly different, respectively 0.94 (range 0.93-0.96), 1.11 (range 1.07-1.16), and 0.82 (range 0.79-0.85). Females and workers have a CR less than unity since in both castes the head is longer than it is broad, while that of the males is greater than unity because the head is broader than long. As will be seen in a later paper, the cephalic ratio is very instructive when ergatandromorphs and intercastes are considered.



FIGS. 4-9. *Monomorium pharaonis* (L.); 4-6, heads; 4, female; 5, male; 6, worker; 7-9, shape and chaetotaxy of clypeus and mandibles; 7, female; 8, male; 9, worker.

SUMMARY

(1) The external characters of the ♀, ♂ and ☿ of *M. pharaonis* (L.) are detailed.

(2) There is a considerable range in length among workers but there is no evidence that it is due to polymorphism. This variation is most probably due to collective and competitive feeding during the association of individuals of different instars. Length variation in males and females is very small.

(3) A convenient way of expressing head shape is by means of the 'Cephalic Ratio' obtained by dividing the greatest width by the greatest length. The cephalic ratios are ♀, 0.94; ♂, 1.11; ☿, 0.82.

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